SOLID ROCKET PLANT

WEAPON SYSTEM 133A

FINAL REPORT

QUALIFICATION-TEST REPORT ON STATHAM DIFFERENTIAL PRESSURE TRANSDUCER

Contract No. AF 33(600)-36610

Report 0162-01DR-24

14 October 1963

AEROJET-GENERAL CORPORATION

SACRAMENTO, CALIFORNIA

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Prepared for

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I. INTRODUCTION

The objective in qualifying a 3-psi-differential pressure transducer is to ensure that the transducer will perform satisfactorily during flight tests of Minuteman second-stage motors. The Statham Instruments, Inc. 3-psi-differential pressure transducer, Model PM730TC, is a modification of the Statham Model PA707TC 5-psi-absolute pressure transducer; it is manufactured in accordance with The Boeing Company Specification D10-20863, Revision C, as amended by Aerojet-General's letter to Space Technology Laboratories, Inc. (STL), "Plus or Minus 3 PSID Pressure Transducers" (SRP-62-4835-L-1), dated 23 January 1962.

II. SUMMARY

The Statham 3-psi-differential pressure transducer, model PM730TC, meets Minuteman requirements on the basis of the following:

A. Data obtained from the qualification tests (Statham Test Report 4131, dated 19 May 1961) of the 5-psi-absolute pressure transducer are applicable to the 3-psi-differential pressure transducer on the basis of similarity of materials, components, and manufacturing processes of the two units.

B. Qualification tests conducted by both Statham and Aerojet in accordance with Aerojet letter to STL, "Qualification of the Psid Pressure Transducer" (SRP: 61:4835:L:137), dated 26 October 1961, and Aerojet letter to STL, "Plus or Minus 3 PSID Pressure Transducers" (SRP: 62-4835-L-1), dated 23 January 1962. Data obtained in these tests are given in this report.

III. APPLICABLE DOCUMENTS

The Boeing Co. Source Control Drawing Specification D10-20863 Revision C	"Airborne Differential Pressure Transducer for Weapon System 133A"
Aerojet-General Corporation letter SRP:63:4835:134, dated 4 October 1961, to Space Technology Laboratories, Inc.	"Minuteman Flight Test Transducer Specification"
Aerojet-General Corporation Letter SRP:61:4835:L:137, dated 26 October 1961, to Space Technology Laboratories, Inc.	"3 PSID Pressure Transducers, Qualification of"
Aerojet-General Corporation letter SRP-62-4935-L-1, dated 23 January 1962, to Space Technology Laboratories, Inc.	"Plus or Minus 3 PSID Pressure Transducer"
Statham Instruments, Inc., Test Report No. 4131, dated 19 April 1961	"Qualification and Reliability Test Report for Statham Absolute Pressure Transducer"

IV. TECHNICAL DISCUSSION

Tests of 3-psi-differential pressure transducers, Model PM730TC, were conducted by Statham and Aerojet to verify that the unit met specifications, as amended. A summary of the tests is given in Figure 1. Except as noted in Figure 1, a minimum of 40 units were subjected to the electrical and performance tests.

A. ELECTRICAL TESTS

Transducer terminal functions are given in Figure 2. Results of the electrical qualification tests are as follows:

IV, A, Electrical Tests (cont.)

1. Bridge Resistance

The brdige resistance was a nominal 350 ohms. Input impedance was a minimum of 700 ohms. Output impedance was 350±35 ohms.

2. Leakage Resistance

The leakage resistance between any terminal and the case was in excess of 1000 megohms when tested with a potential of not more than 50 vdc.

B. PERFORMANCE TESTS, SPECIFIED

The results of performance qualification tests are as follows:

1. Maximum Allowable Differential Pressure

Before and after being subjected to a differential pressure of 150% of the rated range of the 3-psi-differential pressure transducer in either the positive or negative direction, the output voltage of the transducers at atmospheric pressure and zero-differential pressure did not vary more than ±0.5% of the full scale (FS), as specified.

2. Full-Scale Output and Output at Rated Range

Tests indicated the FS output at the positive end of the rated range exceeded, as specified, the output at zero-differential pressure by 25±0.25 mv when operated into a 50,000-ohm, ±10%, load at rated excitation. The output of transducers at the negative end of the rated pressure range was less than the output at zero differential pressure by 25±0.50 mv when operated into a 50,000-ohm, ±10%, load at rated excitation as required by specification.

IV, B, Performance Tests, Specified (cont.)

3. Zero Balance

The output at zero-differential applied pressure and 75±5°F was 25±0.5 mv at rated excitation, as specified.

4. Bridge Standardization

In all tests, the output due to the shunt resistor was equal to a corresponding point on a straight line drawn from the output at 0 psia to the output due to FS pressure within the following tolerances, as required by the specifications: for points 10, 25, 50 and 75% of FS, a tolerance of ±0.15% of FS; for the point at 90% of FS, a tolerance of ±0.20% of FS; for the point at 100% of FS, a tolerance of ±0.25% of FS. Figure 3 lists the output in units for shunt-calibration tests conducted by Aerojet.

5. Nonlinearity, Hysteresis, and Repeatability

Tests in which the transducer was pressurized to obtain input and output curves were made to determine nonlinearity, hysteresis, and repeatability. Pressure cycling of the transducer during the tests was from zero-differential pressure to positive FS; from positive FS through zero-differential pressure to negative FS; and return to zero-differential pressure.

Nonlinearity is defined as the maximum deviation between the input-data curve and a theoretical straight line between the FS-positive and FS-negative end points. The maximum deviation for any differential pressure input was -0.33% of FS (the specification tolerance was ±0.5% of FS).

IV, B, Performance Tests, Specified (cont.)

Hysteresis is defined as the maximum difference between calibration points at any given input stimulus value taken on increasing and decreasing pressure calibrations. The hysteresis envelope is the plot of the output when the pressure is changed from zero-differential pressure to positive FS, to zero-differential pressure, to negative FS, and return to zero-differential pressure. The maximum hysteresis was -0.15% of FS (the specification tolerance was ±0.5% of FS).

Repeatability is defined as the maximum deviation from the average of corresponding data points taken from repeated tests (three each) under static and identical conditions for any one stimulus value. The maximum deviation from the average was +0.09% FS (the specification tolerance was ±0.1% of FS).

The nonlinearity, hysteresis, and repeatability data of tests conducted by Statham is shown in Figure 4.

6. Thermal Coefficient of Sensitivity

The sensitivity change due to temperature was within a diverging error band radiating from a 75°F value with a plus-and minus slope of 0.005% of FS/°F. Within this error band, the slope of the sensitivity shift curve did not exceed 0.01% of FS/°F over the compensated temperature range under temperature-equilibrium conditions. Sensitivity is the change in output in millivolts per unit change in the input stimulus. Figure 5 presents the output data obtained in temperature tests conducted by Statham.

7. Thermal Zero Shift

Zero shift due to temperature was within a diverging error band radiating from the 75°F value with a plus-and-minus slope of 0.01% of FS/°F. Within this error band, the slope of the thermal shift curve did not exceed 0.02% of FS/°F.

IV, B, Performance Tests, Specified (cont.)

8. Acoustic Frequency Response

a. Mismatched Tubing Tests

The test unit (Model PM730TC, SN 6) was subjected to pressure-step functions of 75 psig with a rise time of 15 millisec or less (Figure 6). The pressure steps, applied simultaneously to each port, were applied to the transducer through 40-in.-long tubes; the tube-length mismatch was controlled to within 5%. (Mismatch in tubes of equal diameter is defined as the difference in lengths of the positive- and negative-port connecting tubes divided by the greater tube length.) The bend radius of the tubes was limited to less than 10 times the tube diameter. The duration of the transient output did not exceed 200 millisec. The tests were conducted under simulated flight-staging pressure conditions, and the unit met all performance requirements. Test results are shown in Figures 7 and 8.

b. Matched-Tubing Tests

The test unit (Model PM730TC, SN 9) produced an output of less than 50% of FS, as specified, for a period not exceeding 200 millisec while being subjected to pressure step functions of 5, 10, 20, and 30 psi with a rise time of 15 millisec. The pressure steps, applied simultaneously to each port, were applied to the transducer through both 15- and 60-in.-long tubes. Tube lengths were equal to within 1%. Test results were within the specification limits (Figures 9 and 10).

Matched-tubing tests also were conducted on a 3-psi-differential pressure transducer of an improved design in accordance with Aerojet letter to STL,

IV, B, Performance Tests, Specified (cont.)

"Plus or Minus 3 PSID Pressure Transducers" (SRP-62-4835-L-1), dated 23 January 1962. Tests of the unit, PM730TC, SN 32, were successful. Test data (Figures 11 and 12) indicate that the unit produced an output of less than 10% of FS.

9. Vibration

a. Sinusoidal-Vibration Response

While pressurized, the transducer was vibrated for 15 min in each of the three mutually perpendicular axes (Figure 13). Sinusoidal vibration was measured at the locations where the transducer is mounted to the test fixture. Test data (Figure 14) indicate that the vibration response of the transducer was 0.02% of FS/g (the specification tolerance was 0.1% of FS/g).

b. Static-Acceleration Response

With the transducer circuit energized, the transducer was accelerated for a minimum of 3 min in each of the three mutually perpendicular axes at 15 g. Test data (Figure 15) indicate that the maximum acceleration response of the unit was +0.06% of FS/g in the X axis (the specification tolerance was 0.1% FS/g).

10. Output Change With Line Pressure

Tests were conducted to determine transducer output change when subjected to pressure changes in a vacuum chamber with both ports open. Pressure was applied as a linear function from 15 to 0.15 psia within a time period of 55 ±5 sec, and was later reduced to 0.003 psia. Test results (Figure 16) indicate that the transducer output did not exceed either the allowable maximum limit of 0.1 mv during reduction of the pressure to 0.15 psia or the 1.0-mv limit when reduced to 0.003 psia.

IV, Technical Discussion (cont.)

C. PERFORMANCE TESTS, ADDITIONAL

Two additional performance tests were conducted by Aerojet that were not included in the specifications. The tests and test results were:

1. Damping Effects on Output Caused From Tubing Mismatch

Tests were conducted to determine and compare the damping characteristics induced into the transducer output during transient pressure steps as a result of using rubber and steel tubes with different diameters and lengths, and to determine if excessive tube mismatch would cause damage to the transducer diaphragm. Tubing types and mismatch duplicated flight installation.

The positive- and negative-pressure ports of the transducer were connected to a pressure-pulse generator capable of generating a pressure pulse of 60 psig from 0.1 psia. The pulse characteristics are shown in Figure 6. The transducer pressure-ports to pulse-generator connections were made by the use of connecting tubes. The connecting tubes, which were interchanged during the tests, were standard 1/8-in.-OD by 3/32-in.-ID steel tubing and 1/4-in.-OD by 1/16-in.-ID rubber tubing. Both 28- and 40-in.-long steel and rubber tubing were used. During the tests, the output was monitored by an oscilloscope.

Figures 17 and 18 show the damping characteristics induced into the transducer output from the use of two 40-in.-long steel tubes and two 40-in.-long rubber tubes. Figures 19 and 20 show the effect on transducer output after reversing the connections of the rubber tubes from one port to the other. Figures 21 and 22 show transducer output in tests in which both 40-in.-long-steel and 40-in.-long-rubber tubes were used simultaneously. Figure 23 shows the damping characteristics, with

IV, C, Performance Tests, Additional (cont.)

both 28- and 40-in.-long rubber tubes, of transducer output at various pressure steps. Figure 24 shows test results with the connection of the mismatch tubes reversed.

Test results indicate that the transducer with a tubing mismatch of 30% or less will not be damaged under 60-psig staging pressures. Tests further indicated that steel and rubber tubing can be used interchangeable without detrimental effect on transducer performance. These tests were performed on a transducer of improved design, Model PM730TC, SN 80.

2. Case Sensitivity

Tests were conducted to determine the effect of the torque that is applied to the mounting bracket holddown screws used in supporting the transducer on the Minuteman second-stage motor (Figure 25). Transducer output was monitored by a digital voltmeter while torque was applied to the screws. Normal installation torque is 20 to 25 in.-lb. Test data (Figure 26) indicate that transducer performance will not be affected by applied torque values up to 50 in.-lb.

V. CONCLUSION

Because Statham 3-psi-differential pressure transducer Model PM730TC is similar to Statham 5-psi-absolute pressure transducer Model PA707TC, which was previously qualified by The Boeing Company, and because the electrical and performance tests conducted by Statham and Aerojet were satisfactory, the 3-psi-differential pressure transducer is recommended as a qualified instrument to measure differential pressures on the Minuteman second-stage motor.

Tests Performed*	Tests Performed by Statham	Tests Performed by Aerojet
Bridge resistance	*	*
Full scale output and output at rated range	*	*
Zero balance	*	*
Bridge standardization		*
Leakage resistance	*	*
Maximum allowable differential pressure	*	*
Non-linearity, hysteresis and repeatability	*	*
Thermal coefficient of sensitivity	*	*
Thermal zero shift	*	*
Acoustic frequency response	*	
Sinusoidal vibration sensitivity**	*	
Static acceleration sensitivity**	*	
Output change with line pressure**	*	
Acoustic response tube mismatch***	*	*
Case sensitivity***	*	*

* Tests performed on a minimum of 40 units except as indicated.
** Performed on five units only.
*** Performed on one unit only.

NOTE: Acceptance tests of each unit manufactured are performed. The acceptance tests include all but the last six tests listed above.

Qualification-Test Summary

Figure 1

Terminal Number	Function
A	Positive (+) Excitation
B	Positive (+) output
C	Negative (-) output
D	Negative (-) excitation
E) F)	For shunt calibration (E connected internally to C, and F to D)

Figure 2. Transducer-Terminal Functions

% OF FULL SCALE	SHUNT VALVE IN OHMS	TRANSDUCER OUTPUT, IN UNITS	MIN-MAX LIMITS
0	INFINITY	X	X
10	336,600	1000	985 1015
25	134,400	2498	2485 2515
50	66,970	4997	4985 5015
75	44,500	7498	7485 7515
90	37,010	9000	8980 9020
100	33,270	10,000	9975 10,025

X = NOT APPLICABLE

10,000 UNITS = 100% OF FULL SCALE

TRANSDUCER SERIAL NO. 80

Figure 3. Output in Millivolts for Shunt Calibration Tests by Aerojet-General

Figure 2 and Figure 3

3-psi Differential
Pressure Transducer,
Statham Model PM730TC

Input Resistance 985.7 Ohms
Output Resistance 332.6 Ohms
Insulation Resistance 10,000 Megohms

PRESSURE PSID	OUTPUT MILLIVOLTS					
	PLUS	MINUS	PLUS	MINUS	PLUS	MINUS
0.0	24.693	24.712	24.691	24.707	24.690	24.709
0.6	29.745	19.740	29.735	19.759	29.751	19.771
1.2	34.780	14.766	34.756	14.776	34.794	14.794
1.8	39.790	9.793	39.758	9.791	39.792	9.821
2.4	44.772	4.815	44.753	4.803	44.800	4.850
3.0	49.761	-0.146	49.725	-0.131	49.805	-0.099
2.4	44.788	4.824	44.718	4.830	44.723	4.834
1.8	39.723	9.785	39.700	9.812	39.757	9.830
1.2	34.751	14.770	34.712	14.784	34.784	14.786
0.6	29.692	19.745	29.701	19.769	29.730	19.761
0.0	24.686	24.704	24.686	24.703	24.687	24.702

Maximum Non-Linearity -0.33 % Full Scale
Maximum Hysteresis -0.15 % Full Scale
Repeatability +0.09 % Full Scale
Serial No. 1

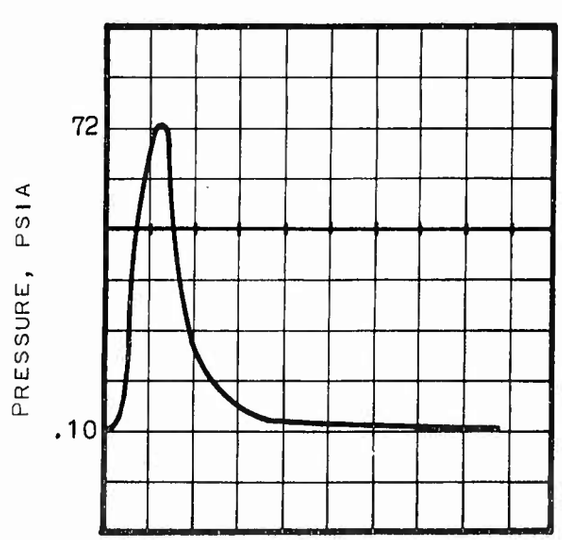
Pressure-Cycling Data for Nonlinearity, Hysteresis, and Repeatability

Figure 4

DIFFERENTIAL PRESSURE PSI	OUTPUT MILLIVOLTS							
	+30°F		+75°F		+130°F		+250°F	
	PLUS	MINUS	PLUS	MINUS	PLUS	MINUS	PLUS	MINUS
0	24.794	24.820	24.755	24.778	24.850	24.871	24.391	24.411
1.5	37.357	12.402	37.352	12.350	37.436	12.434	36.953	11.936
3.0	49.825	-0.036	49.856	-0.056	49.896	+0.045	49.435	-0.478
1.5	37.352	12.380	37.353	12.340	37.409	12.416	36.895	11.943
0	24.798	23.816	24.761	24.783	24.840	24.869	24.382	24.415

Serial No. 1

Figure 5. Sensitivity Shift Due to Temperature Changes



VERTICAL SENSITIVITY: 5 MV/DIV

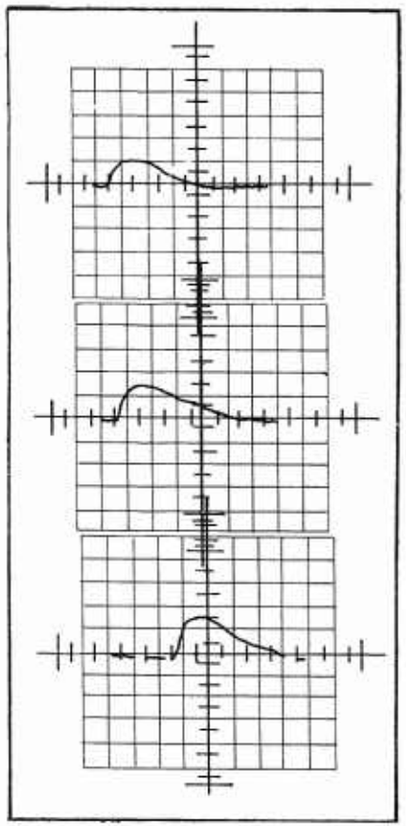
PEAK VALUE: 72 PSIA

SWEEP RATE: 50 MILLISEC/DIV

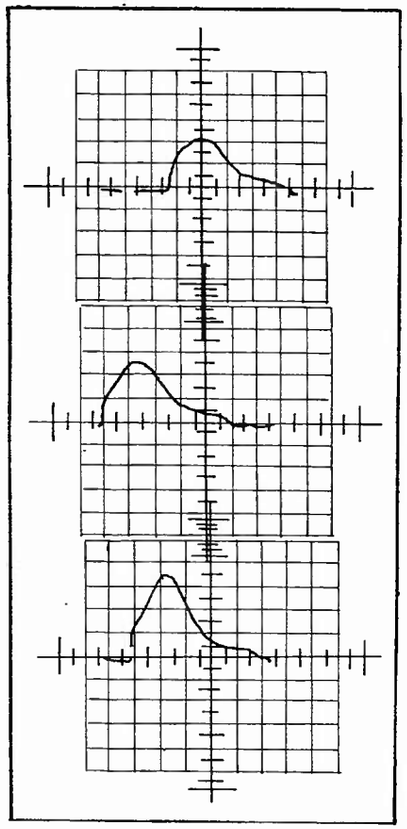
DURATION: 136 MILLISEC

Figure 6. Simulated Staging Pressure Pulse

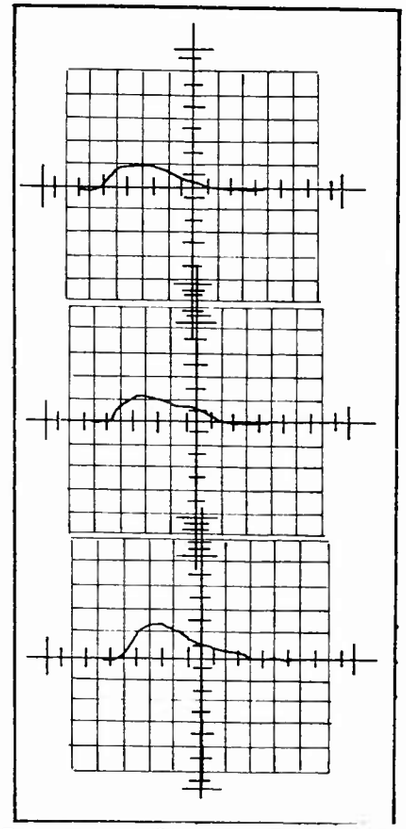
Figure 5 and Figure 6



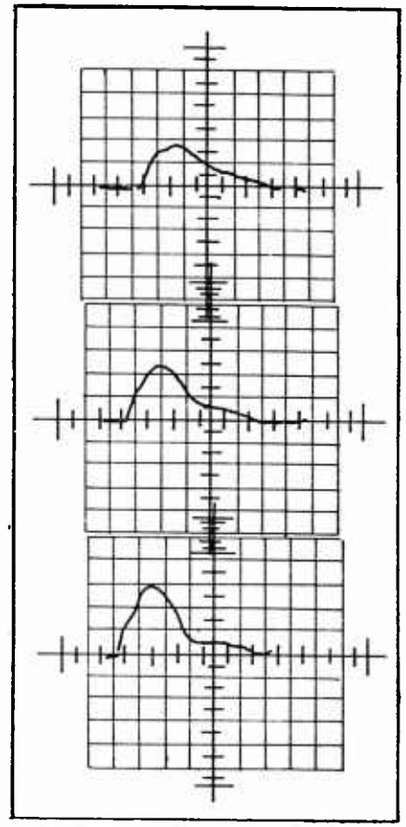
PRESSURE STEPS, READING
FROM TOP: 10, 20, 30 PSIG



PRESSURE STEPS, READING
FROM TOP: 40, 50, 60 PSIG



PRESSURE STEPS, READING
FROM TOP: 10, 20, 30 PSIG



PRESSURE STEPS, READING
FROM TOP: 40, 50, 60 PSIG

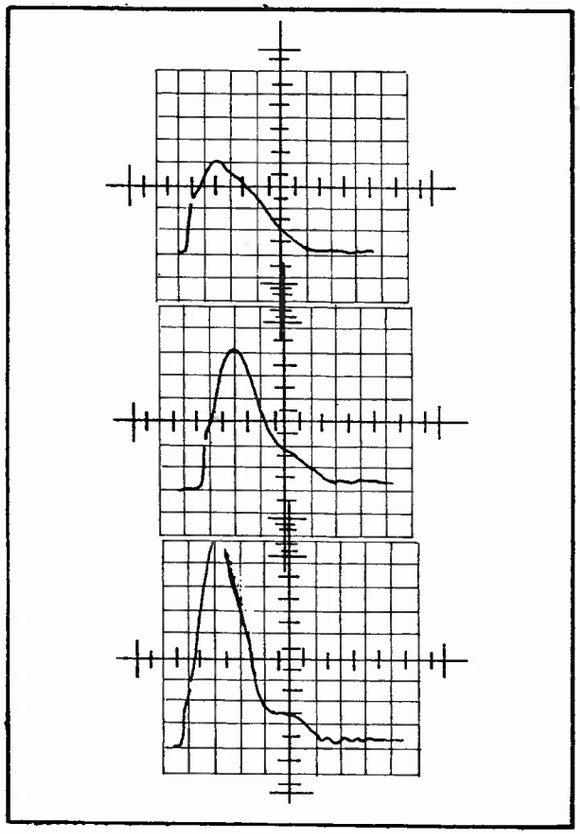
42-IN. COPPER TUBE ON POSITIVE SIDE
40-IN. COPPER TUBE ON NEGATIVE SIDE

40-IN. COPPER TUBE ON POSITIVE SIDE
42-IN. COPPER TUBE ON NEGATIVE SIDE

SCOPE SENSITIVITY: 0.4 PSI/CM
15 MILLISEC RISE TIME
20 MILLISEC/CM SWEEP TIME
INPUT VOLTAGE 7.5

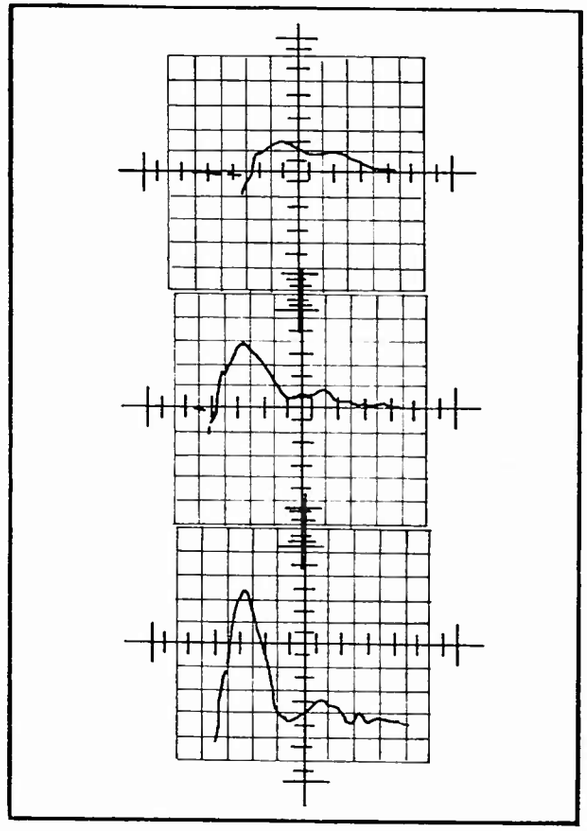
Figure 7

Comparative Data, Acoustic Frequency-Response Tests of 3-psi Differential Pressure Transducer (SN 6) With 1/8-in.-dia Copper Connecting Tubes Interchanged



PRESSURE STEPS, READING FROM
TOP: 30, 50, 75 PSIG

42-IN. COPPER TUBE WITH 3 LOOPS ON
POSITIVE SIDE
40-IN. STRAIGHT COPPER TUBE ON NEGATIVE SIDE



PRESSURE STEPS, READING FROM
TOP: 30, 50, 75 PSIG

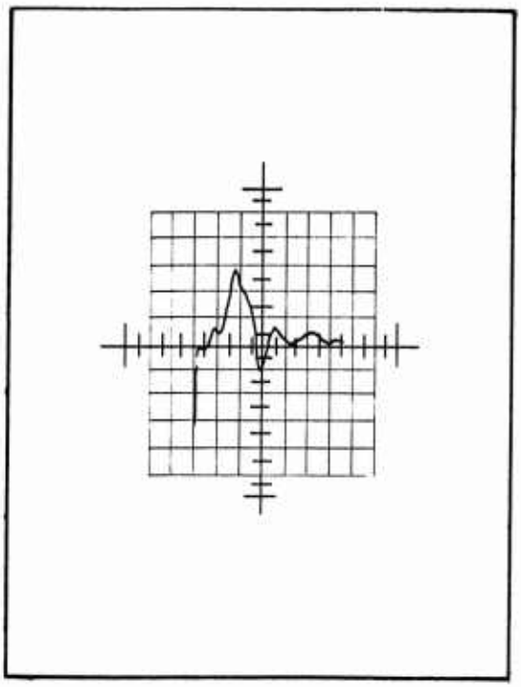
40-IN. STRAIGHT COPPER TUBE ON POSITIVE SIDE

42-IN. COPPER TUBE WITH 3 LOOPS ON NEGATIVE SIDE

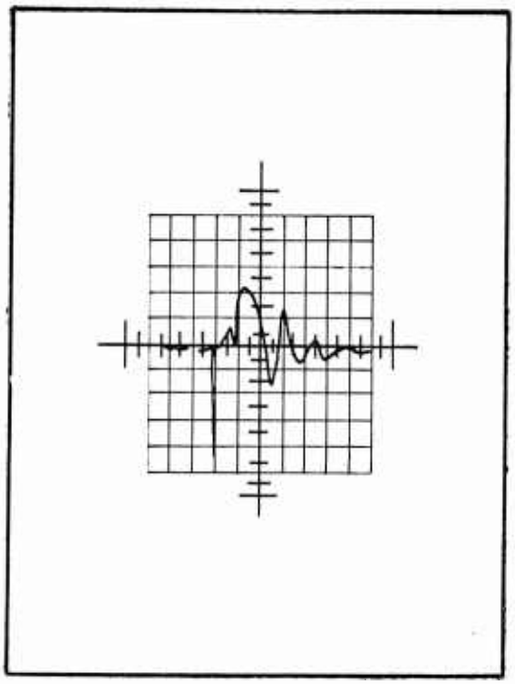
SCOPE SENSITIVITY: 0.2 PSI/CM
INPUT VOLTAGE: 7.5
15 MILLISEC RISE TIME
20 MILLISEC/CM SWEEP TIME

Figure 8

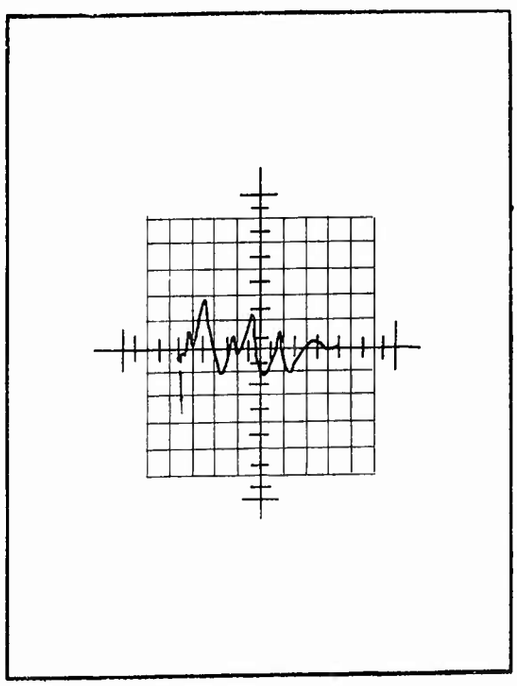
Comparative Data, Acoustic Frequency-Response Tests of 3-psi Differential Pressure Transducer (SN 6) With 1/8-in.-dia Copper Connecting Tubes With Three 1.25-in.-dia Loops



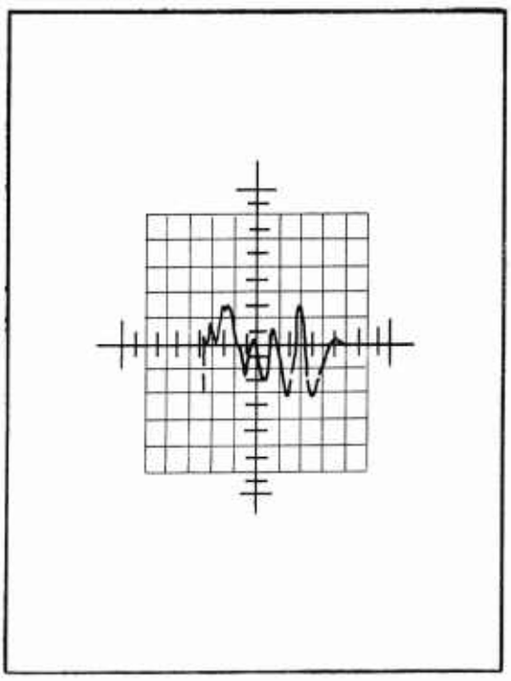
PRESSURE STEP: 5 PSIG



PRESSURE STEP: 10 PSIG



PRESSURE STEP: 20 PSIA

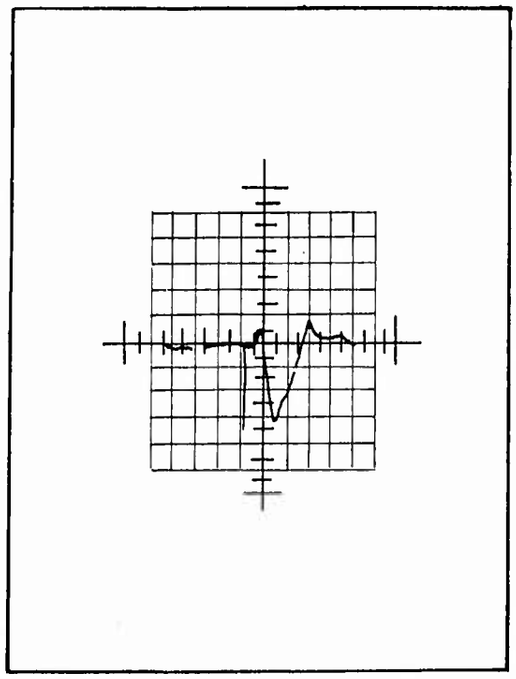


PRESSURE STEP: 30 PSIG

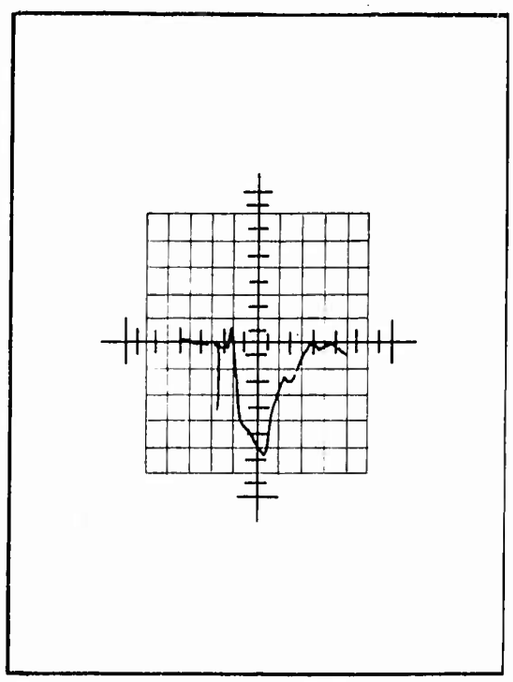
SCOPE SENSITIVITY: 0.2 PSI/CM
5 MILLISEC RISE TIME
10 MILLISEC/CM SWEEP TIME
INPUT VOLTAGE: 7.5
R-IN: 338.8Ω R-OUT: 338.1Ω

Output Data, Acoustic Frequency-Response Test, 3-psi Differential Pressure Transducer (SN 9) With Matched 15-in.-long Copper Connecting Tubes, 1/8 in. dia

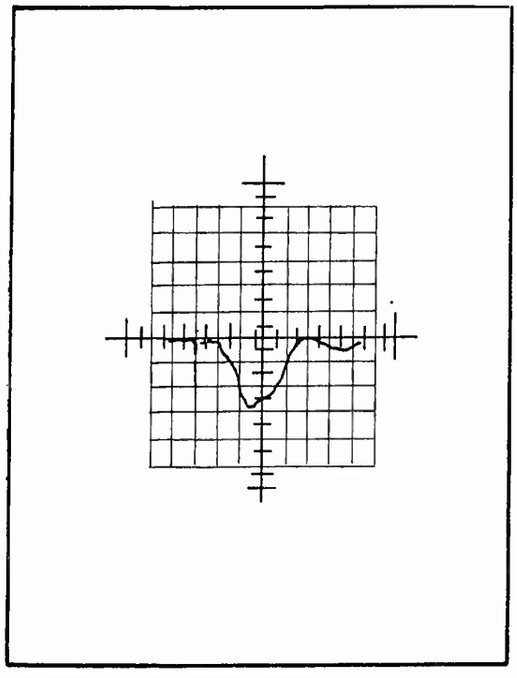
Figure 9



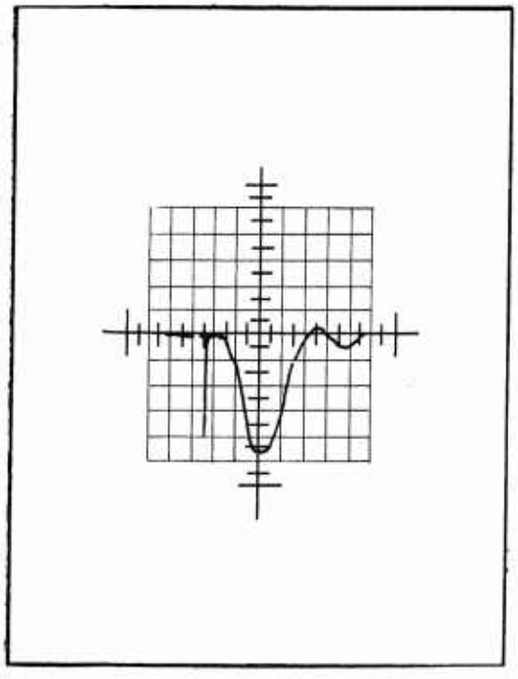
PRESSURE STEP: 5 PSIG



PRESSURE STEP: 10 PSIG



PRESSURE STEP: 20 PSIG

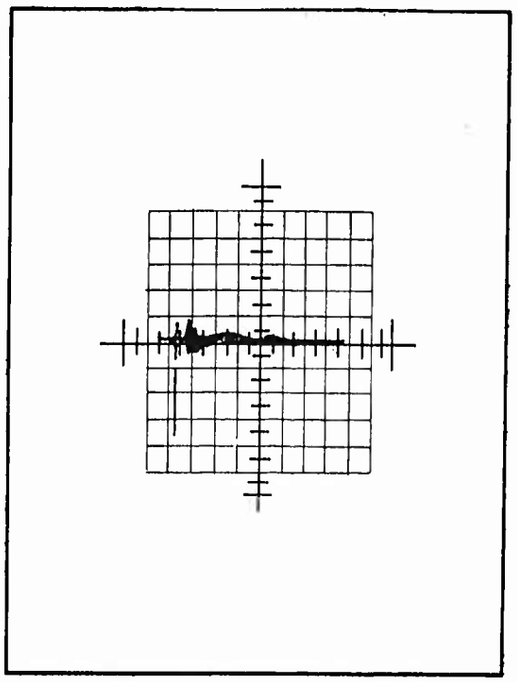


PRESSURE STEP: 30 PSIG

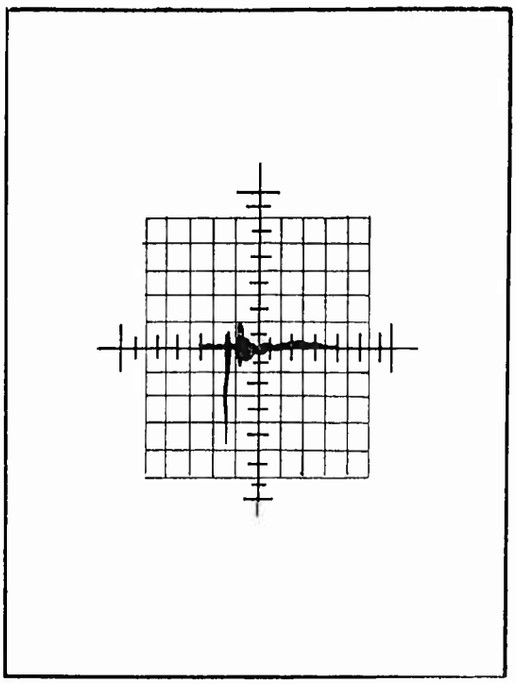
SCOPE SENSITIVITY: 0.2 PSI/CM
5 MILLISEC RISE TIME
10 MILLISEC/CM SWEEP TIME
INPUT VOLTAGE: 7.5
R-IN: 338.8Ω R-OUT: 338.1Ω

Output Data, Acoustic Frequency-Response Test, 3-psi Differential Pressure Transducer (SN 9) With 60-in.-long Copper Connecting Tubes, 1/8 in. dia

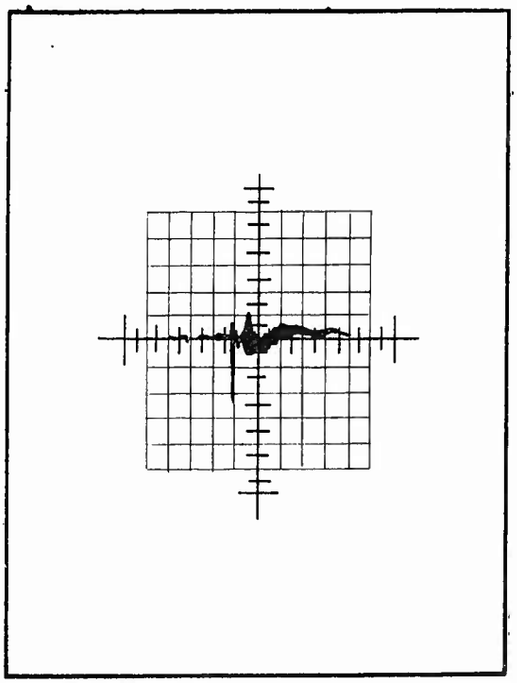
Figure 10



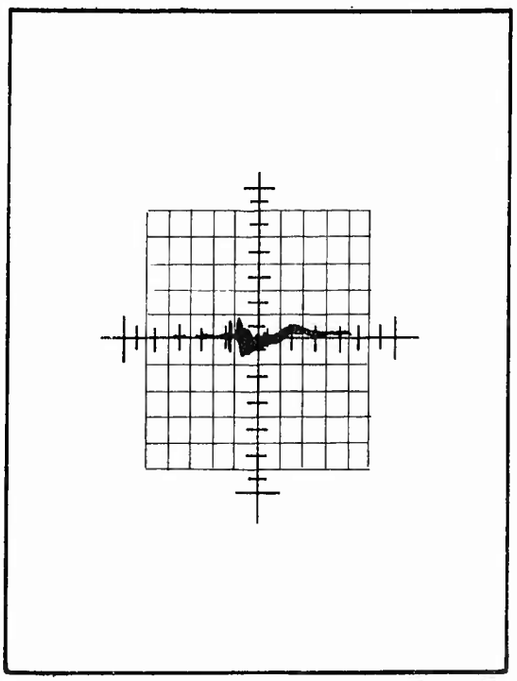
PRESSURE STEP: 5 PSIG



PRESSURE STEP: 10 PSIG



PRESSURE STEP: 20 PSIG

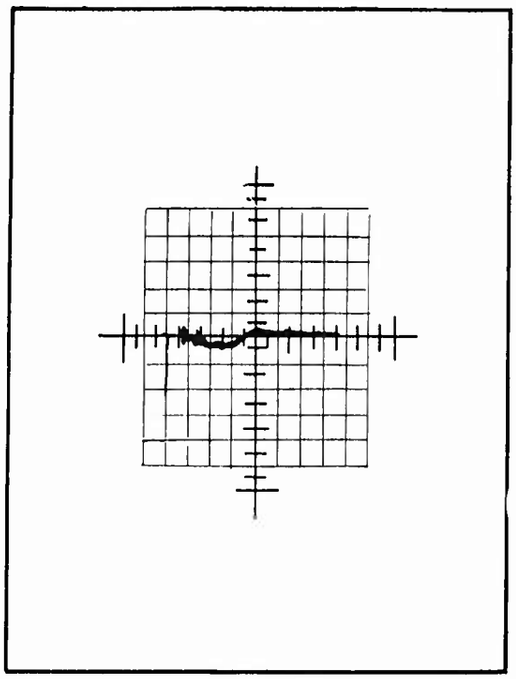


PRESSURE STEP: 30 PSIG

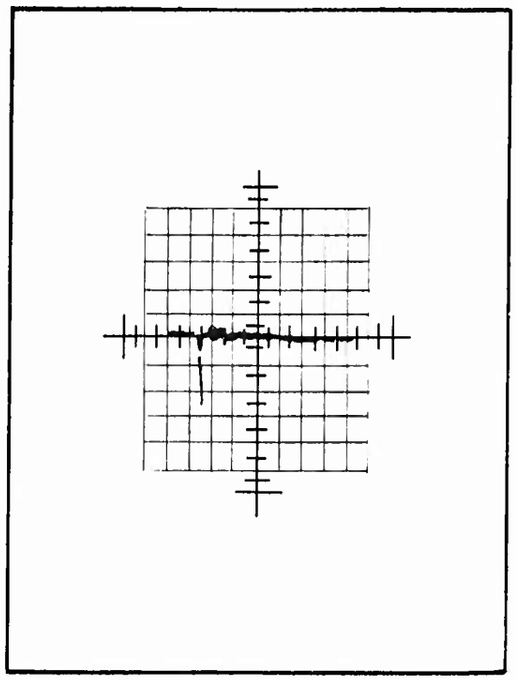
SCOPE SENSITIVITY: 0.2 PSI/CM
5 MILLISEC RISE TIME
10 MILLISEC/CM SWEEP TIME
INPUT VOLTAGE: 7.5
R-IN: 336.0Ω R-OUT: 335.1Ω

Output Data, Acoustic Frequency-Response Test, 3-psi Differential Pressure Transducer (SN 32) With 15-in.-long Copper Connecting Tubes, 1/8 in. dia

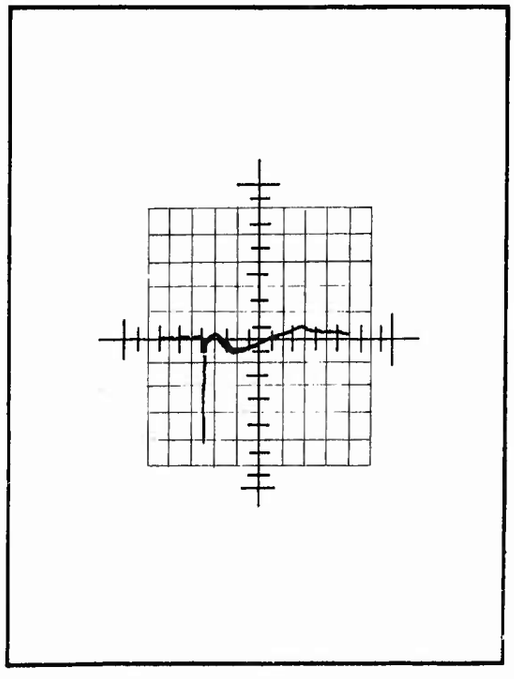
Figure 11



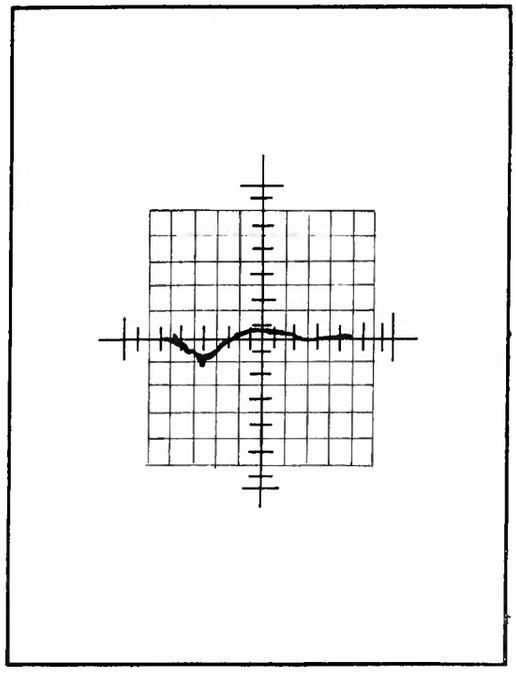
PRESSURE STEP: 5 PSIG



PRESSURE STEP: 10 PSIG



PRESSURE STEP: 20 PSIG



PRESSURE STEP: 30 PSIG

SCOPE SENSITIVITY: 0.2 PSI/CM
5 MILLISEC RISE TIME
10 MILLISEC/CM SWEEP TIME
INPUT VOLTAGE: 7.5
R-IN: 336.0Ω R-OUT: 335.1Ω

Output Data, Acoustic Frequency-Response Test, 3-psi Differential Pressure Transducer (SN 32) With 60-in.-long Copper Connecting Tubes, 1/8 in. dia

Figure 12

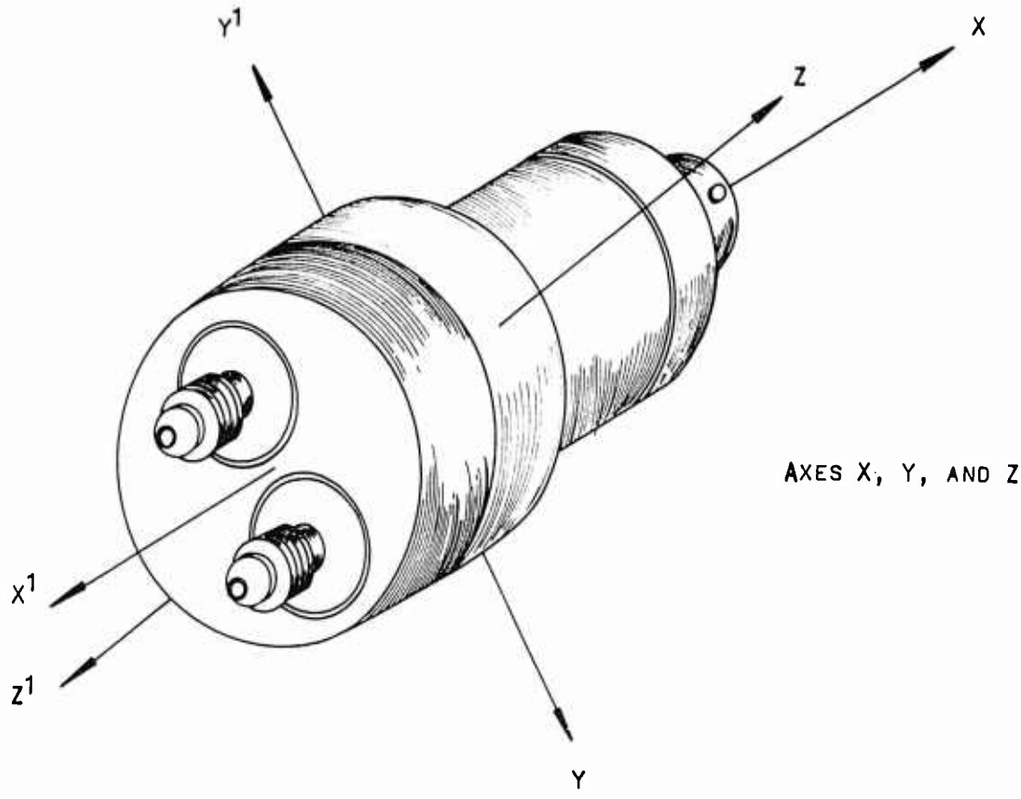


Figure 13. Definition of Axes, Vibration-Response Tests

AXIS	OUTPUT, % FS/g
X	<0.02
Y	<0.02
Z	<0.02

Serial No. 1

Figure 14. Sinusoidal-Vibration-Response Data

Figure 13 and Figure 14

AXIS	OUTPUT, % FS/g
X	+0.06
X^1	-0.06
Y	-0.01
Y^1	-0.03
Z	-0.02
Z^1	-0.02

Serial No. 1

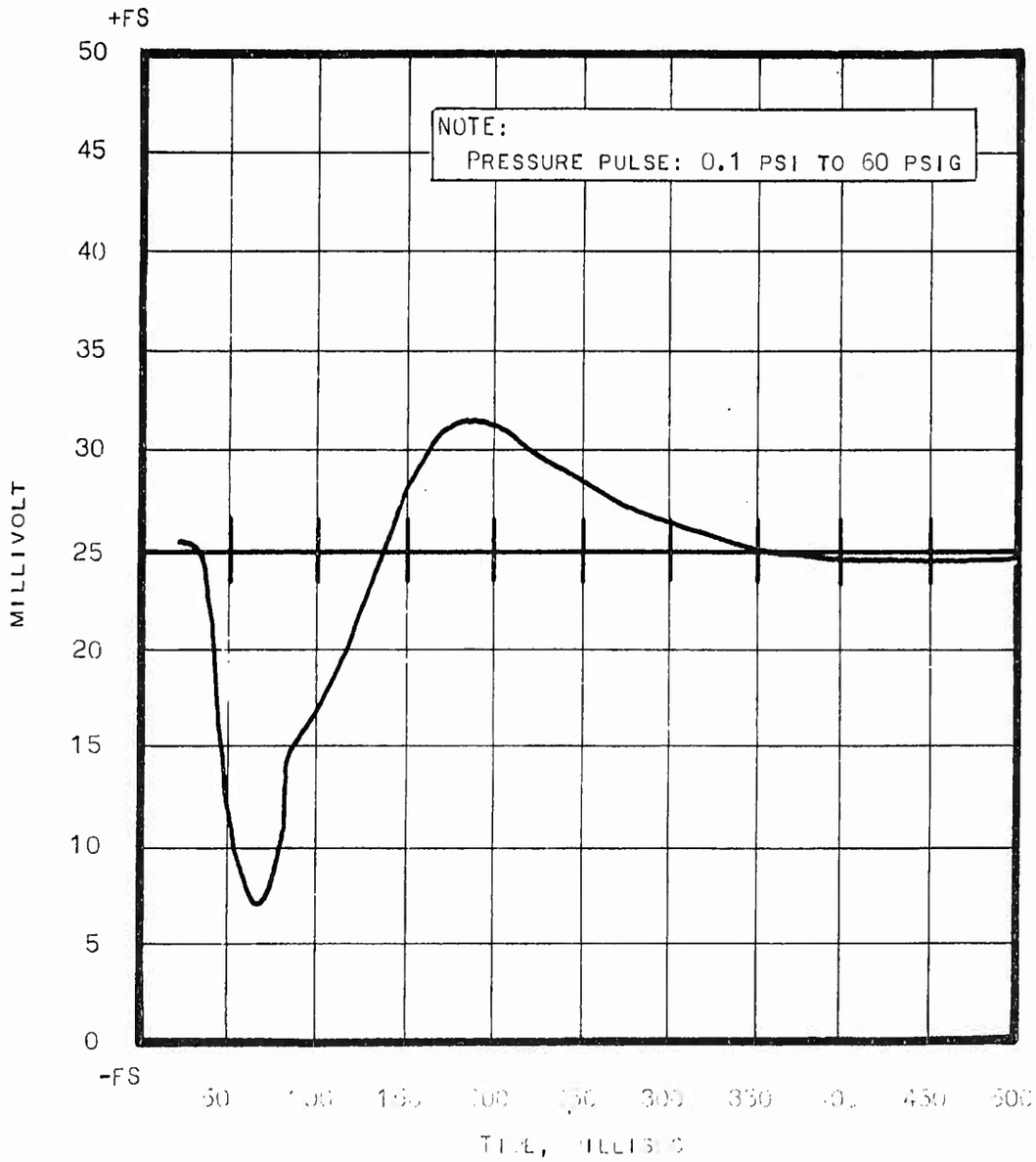
Figure 15. Static-Acceleration-Response Data

PRESSURE, PSIA	OUTPUT, MILLIVOLTS
15.0	25.182
0.15	25.168
0.003	25.196

Serial No. 1

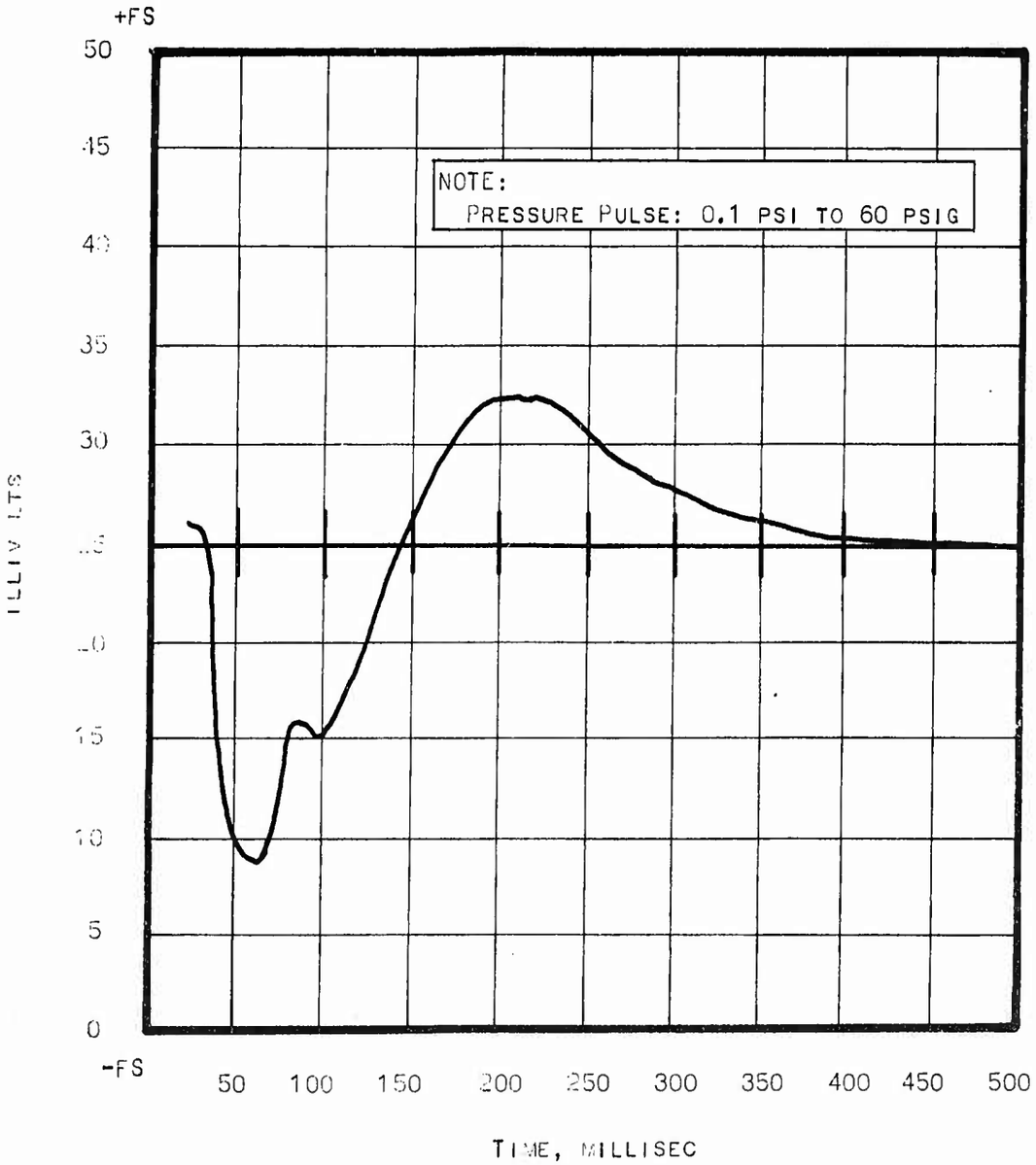
Figure 16. Output During Line Pressure Test

Figure 15 and Figure 16



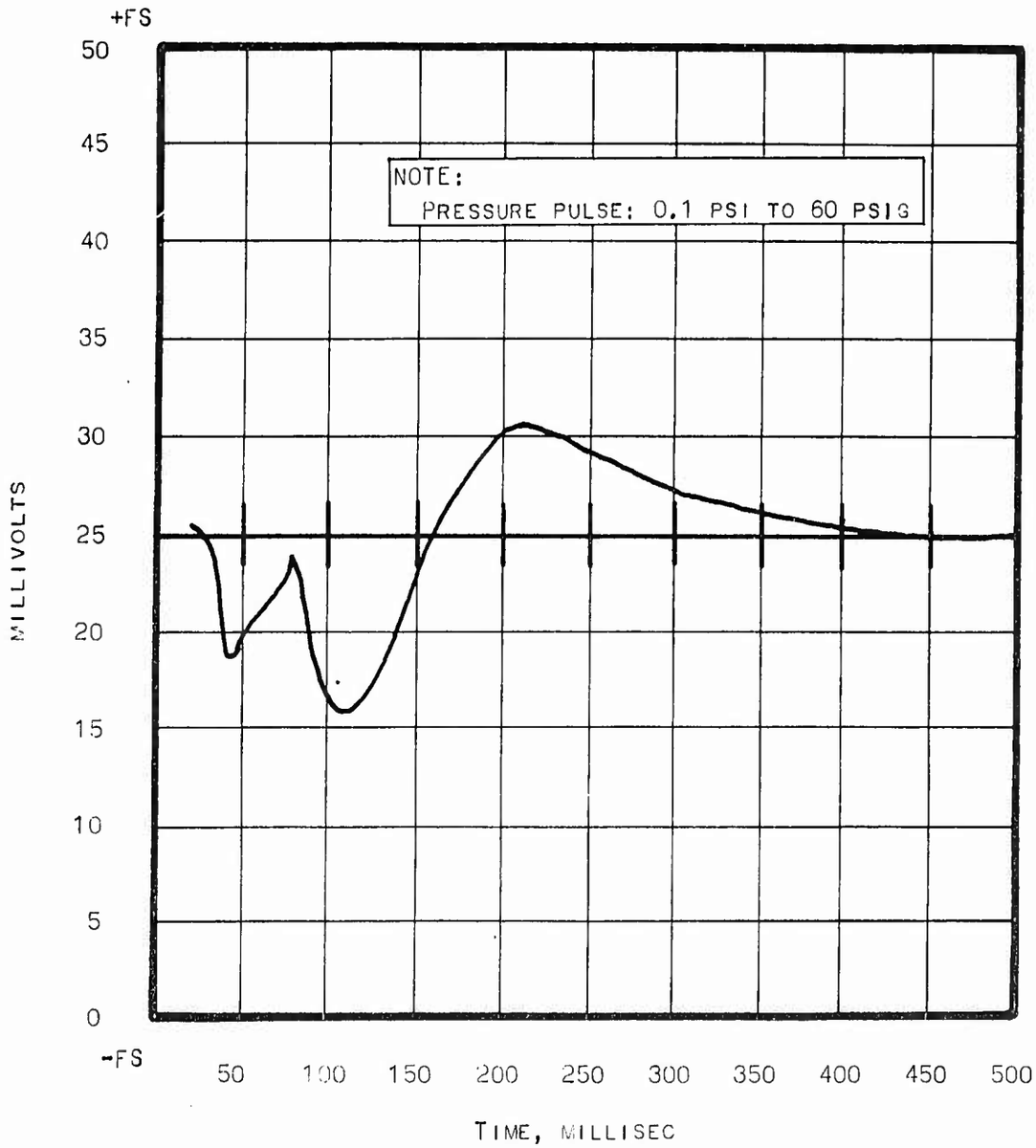
Damping Characteristics, Acoustic-Response Test 1 With 40-in.-long Steel Tubes

Figure 17



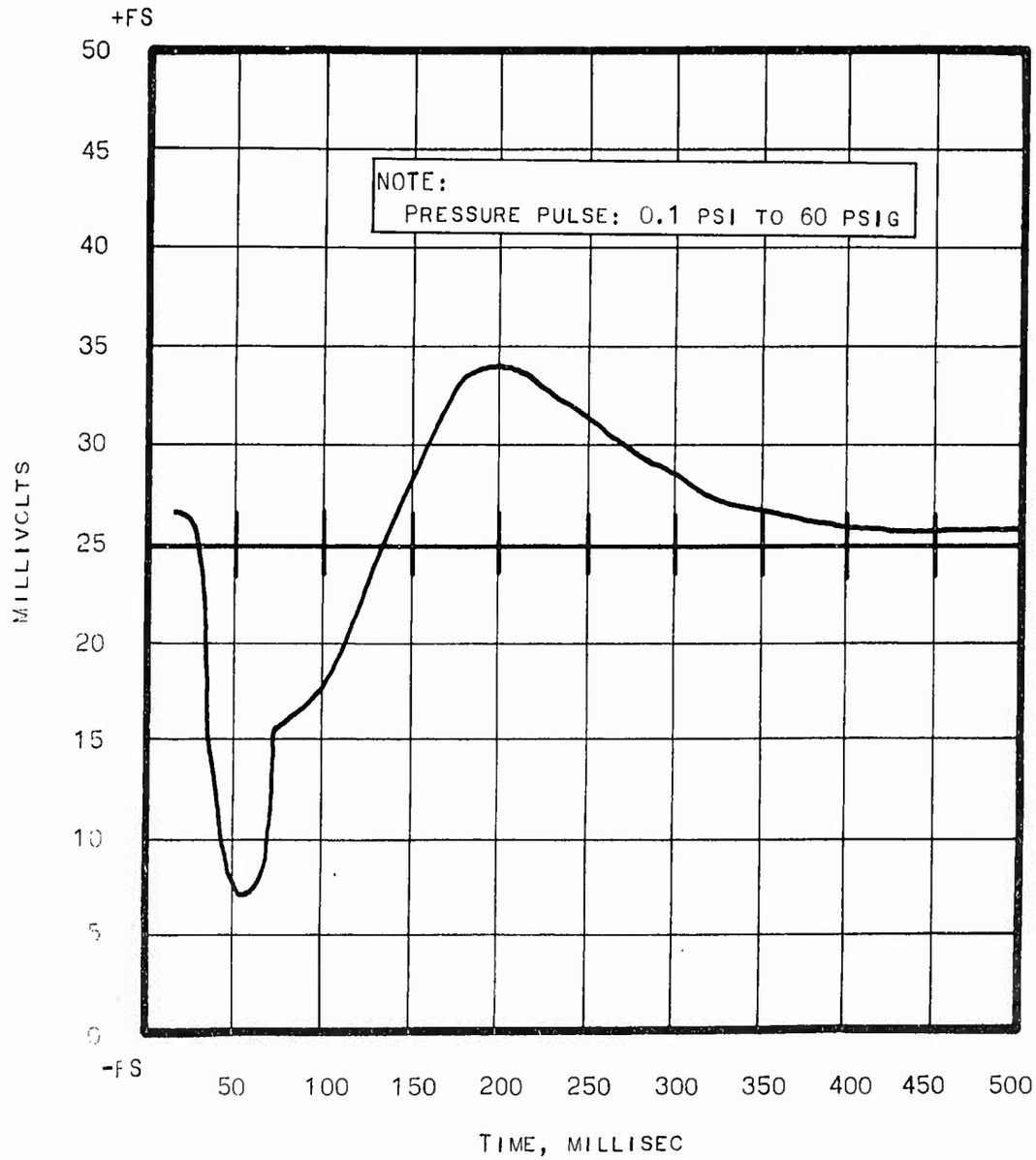
Damping Characteristics, Acoustic-Response Test 2 With 40-in.-long Rubber Tubes

Figure 18



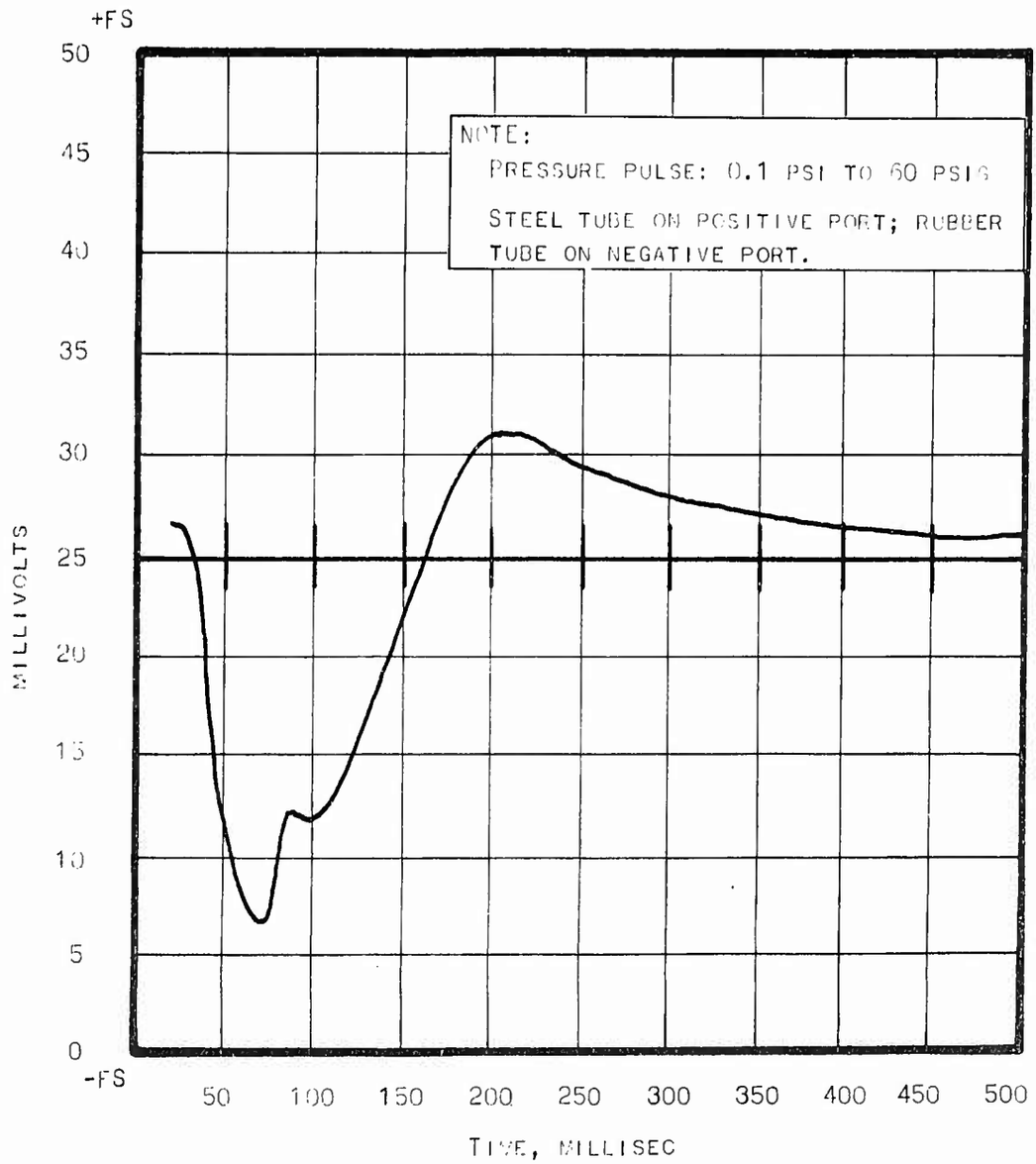
Damping Characteristics, Acoustic-Response Test 3 With 40-in.-long Rubber Tubes

Figure 19



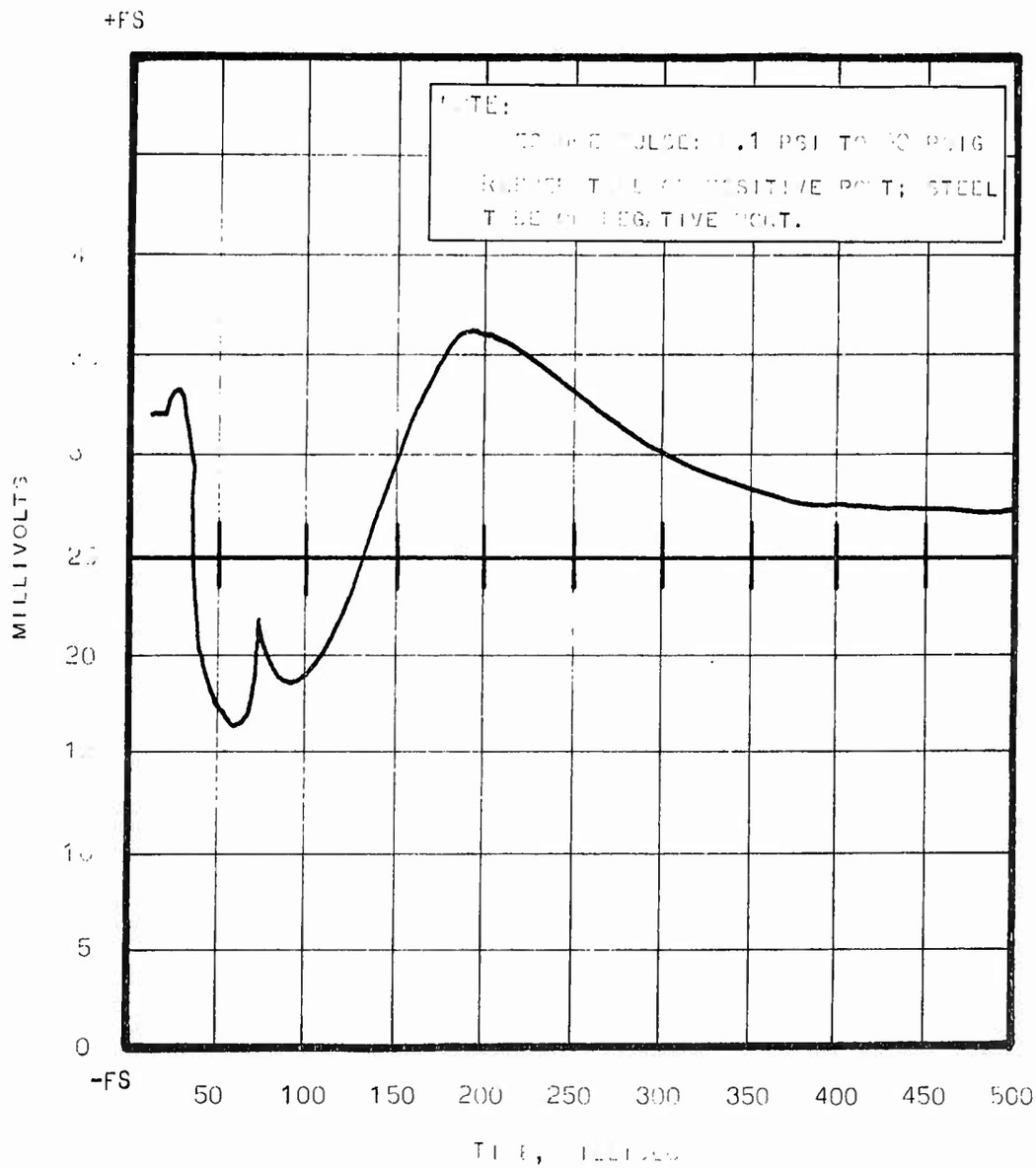
Damping Characteristics, Acoustic-Response Test 4 With Connecting Tubes Reversed From Test 3

Figure 20



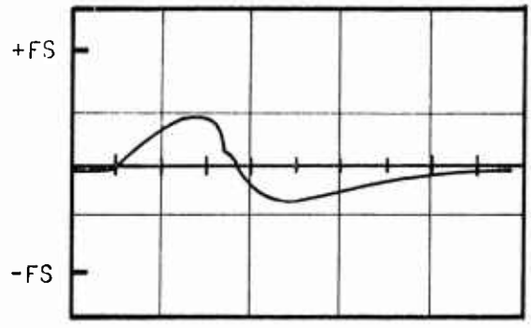
Damping Characteristics, Acoustic-Response Test 5 With 40-in.-long Steel and Rubber Connecting Tubes

Figure 21

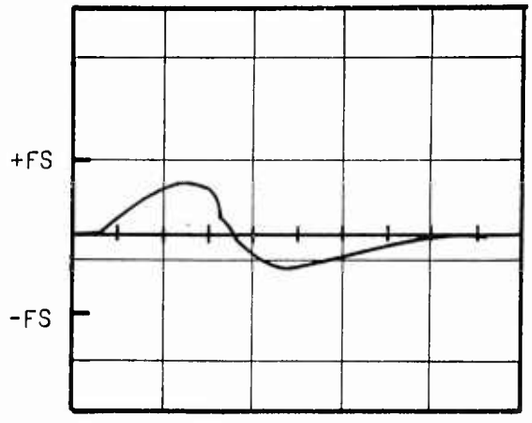


Damping Characteristics, Acoustic-Response Test 6 With Connecting Tubes Reversed From Test 5

Figure 22



PRESSURE STEP: 10 PSIG



PRESSURE STEP: 20 PSIG

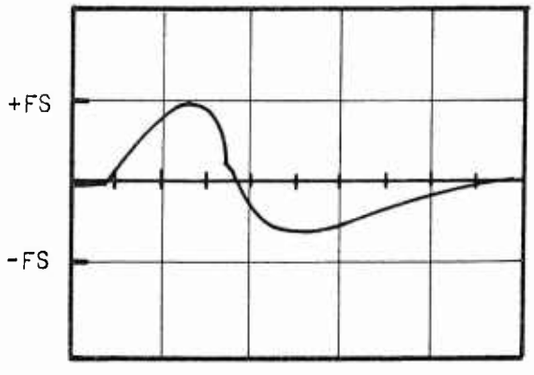
RISE TIME: 10.9 MV/DIV FOR 10 PSIG PRESSURE STEP

RISE TIME: 16.0 MV/DIV FOR 20, 40, 60 PSIG PRESSURE STEP

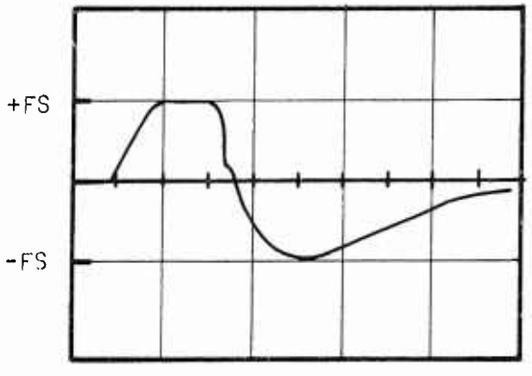
SWEEP TIME: 20 MILLISEC/DIV

28-IN. RUBBER TUBE CONNECTED TO POSITIVE PORT

40-IN. RUBBER TUBE CONNECTED TO NEGATIVE PORT



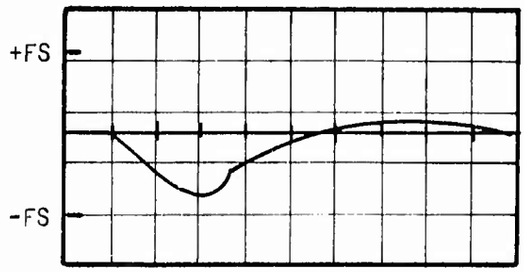
PRESSURE STEP: 40 PSIG



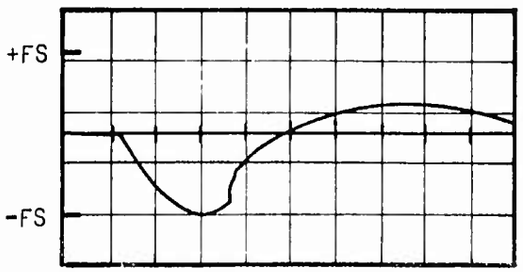
PRESSURE STEP: 60 PSIG

Damping Characteristics, Acoustic-Response Test 7 With 28- and 40-in.-long Rubber Connecting Tubes (SN 80)

Figure 23



PRESSURE STEP: 10 PSIG



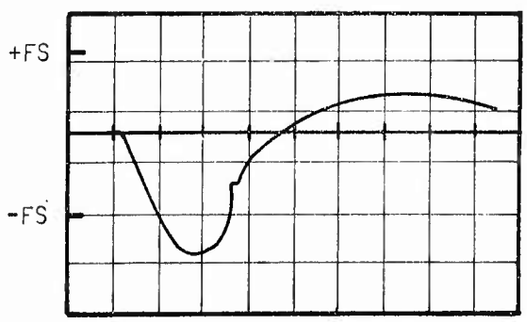
PRESSURE STEP: 20 PSIG

RISE TIME: 10.0 MV/DIV

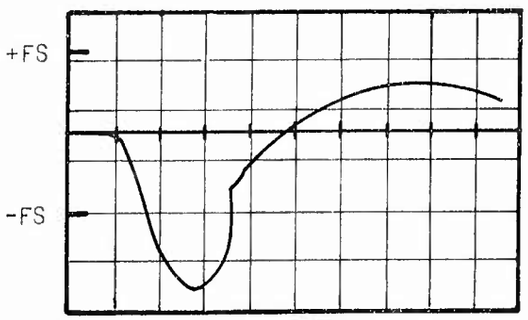
SWEEP TIME: 20 MILLISEC/DIV

40-IN. RUBBER TUBE CONNECTED TO POSITIVE PORT

28-IN. RUBBER TUBE CONNECTED TO NEGATIVE PORT



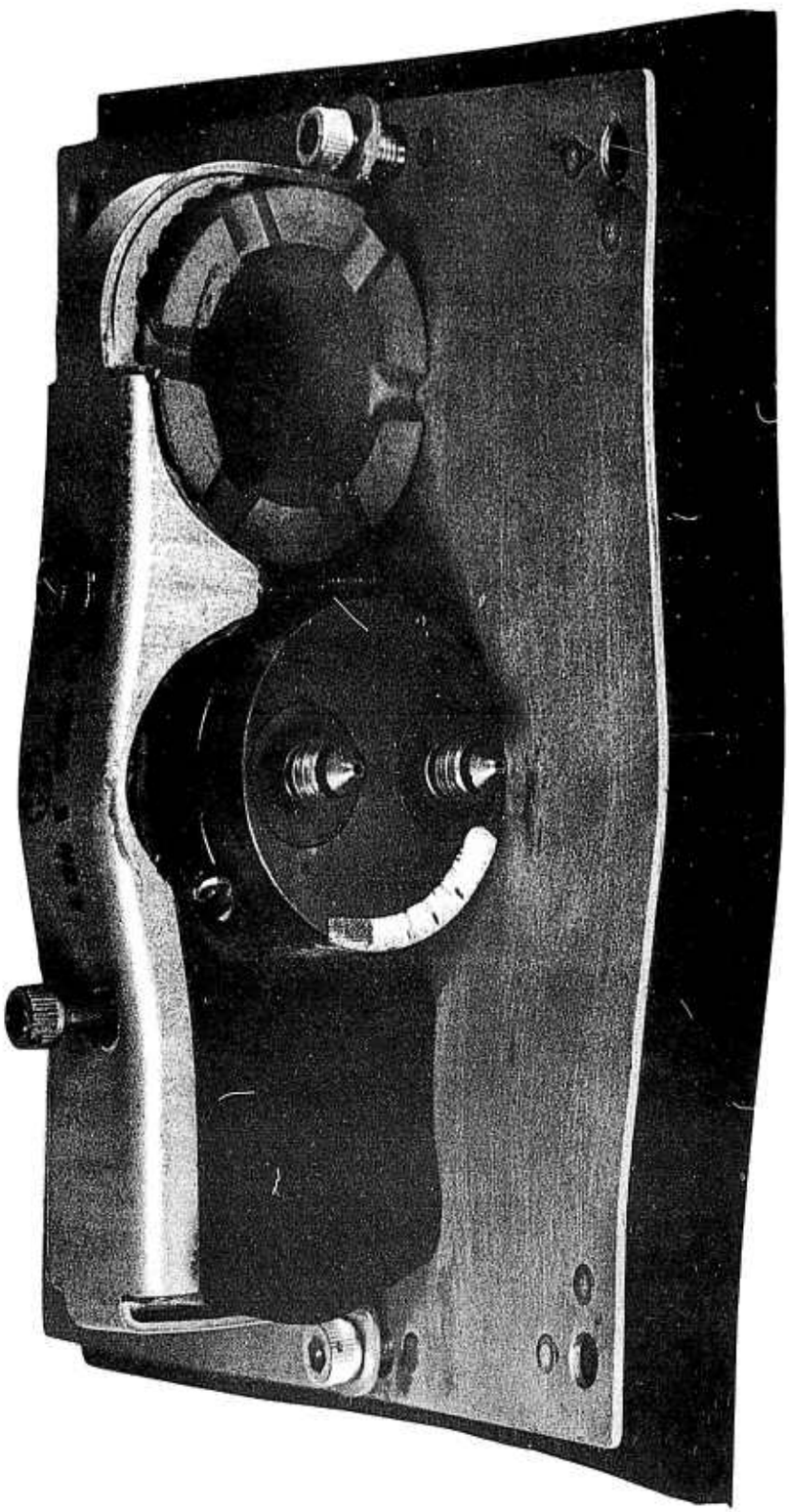
PRESSURE STEP: 40 PSIG



PRESSURE STEP: 60 PSIG

Damping Characteristics, Acoustic-Response Test 8 With Connecting Tubes Reversed From Test 7 (SN 80)

Figure 24



Test Setup, Case-Sensitivity Test (Photo 8-62S 20360)

Figure 25

Torque, in.-lb	Output, mv
0	25.0
25	25.0
30	25.0
35	25.0
40	25.0
50	25.0

* Test performed on one unit only.

Case-Sensitivity-Test Data

Figure 26